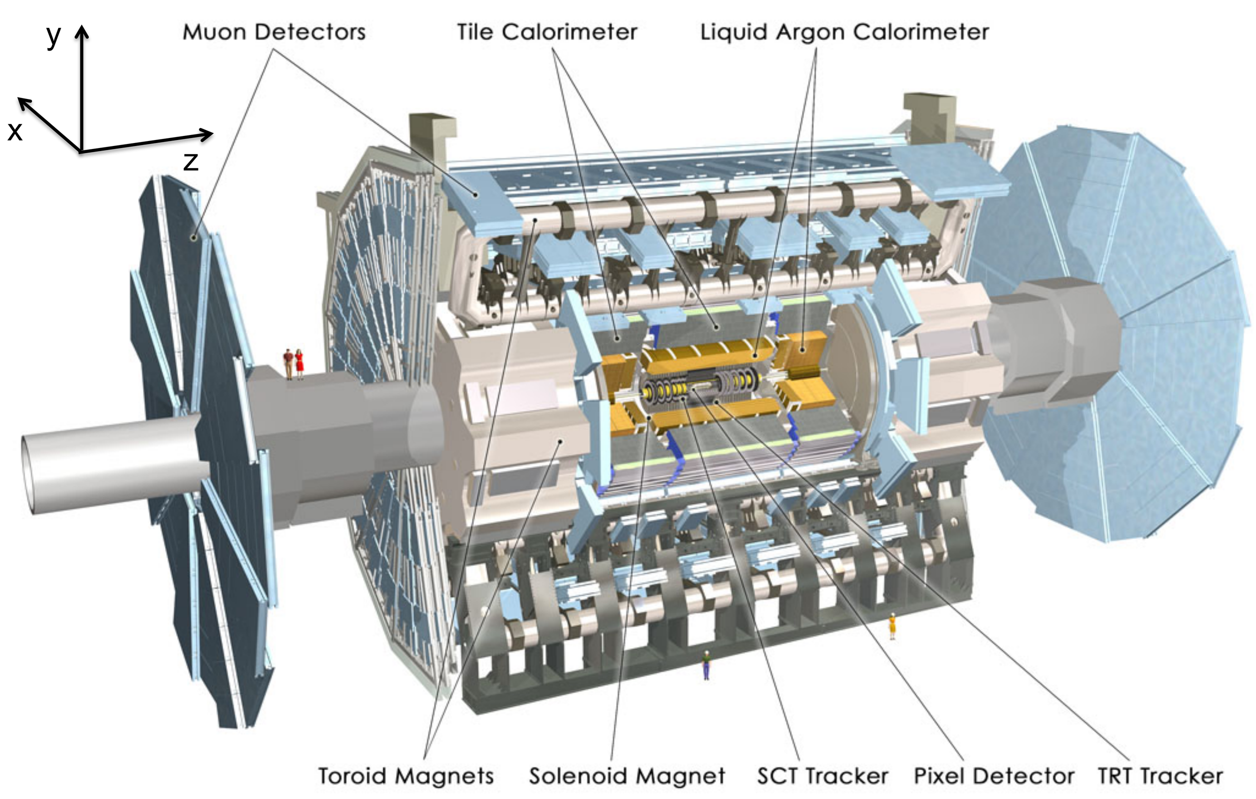
PLHC POSTER SESSION – PERUGIA, JUNE 2011

Refined reconstruction and calibration of the missing transverse energy in the ATLAS detector

Intruduction: E_T^{miss} motivation

The missing transverse energy (E_T^{miss}) signals the presence of either weakly interacting particles or particles missing detection or any problem in the detector. So, an optimal E_T^{miss} evaluation, including the setting of its absolute scale, is crucial for the study of many physics channels in the Standard Model as W, tt, H→ ττ or of discovery channels for SUSY and extra dimensions.

E_T^{miss} definition



E_T^{miss} is a complex event quantity, It is calculated adding all significant signals from all detectors:

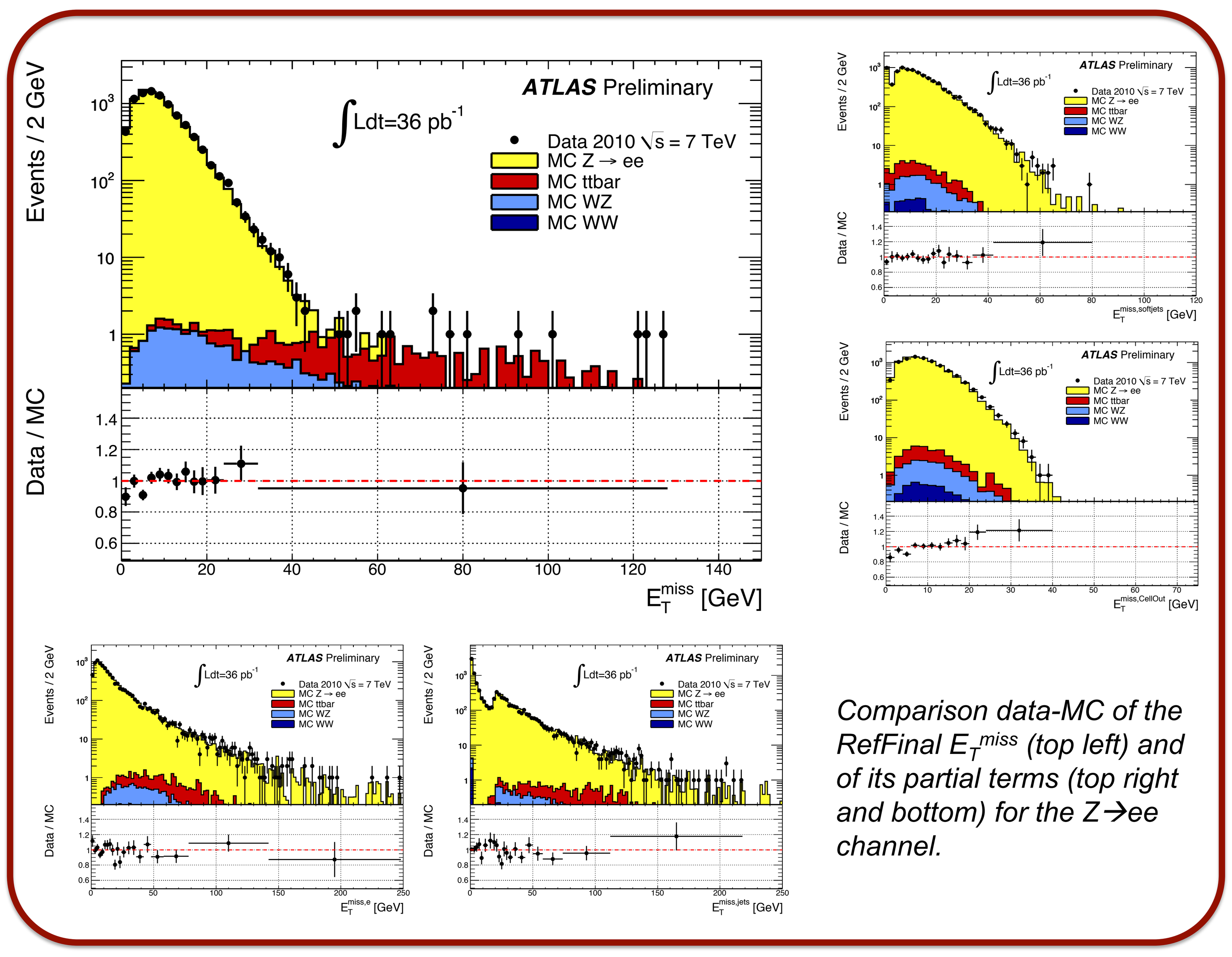
- Calorimeters signals
- Muon signals
- Tracks in region where the Calorimeter and the Muon Spectrometer are inefficient

E_T^{miss} is obtained by asking for energy conservation in the transverse (x-y) plane:

$$E_{x,y}^{miss} = -\sum E_{x,y} \quad \{ \text{Sum of energy of all particles seen in the detector}$$

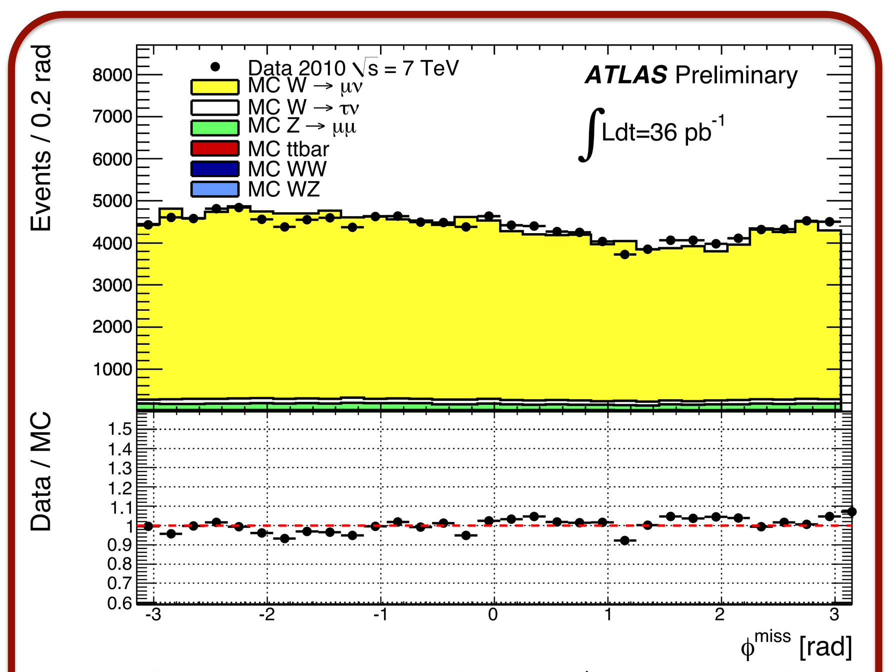
$$E_T^{miss} = \sqrt{(E_x^{miss})^2 + (E_y^{miss})^2} \qquad \phi^{miss} = arctan(E_y^{miss} / E_x^{miss})$$

Main results with 2010 data

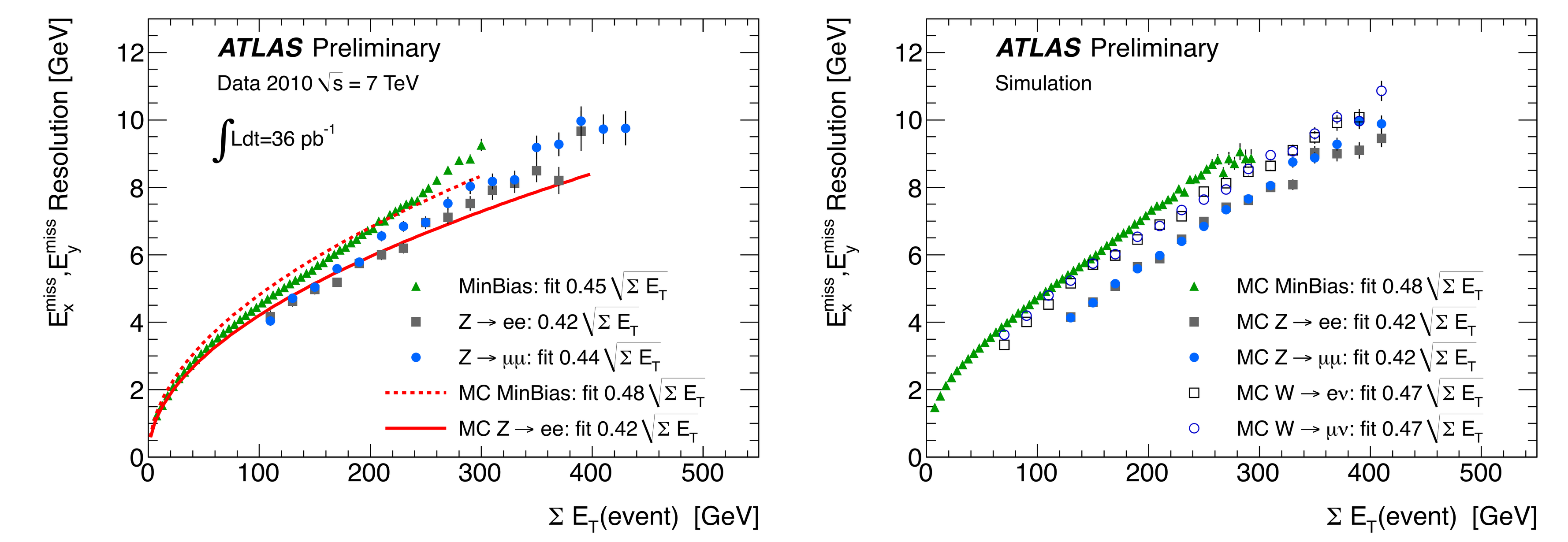


Comparison data-MC of the RefFinal E_T^{miss} (top left) and of its partial terms (top right and bottom) for the Z→ee channel.

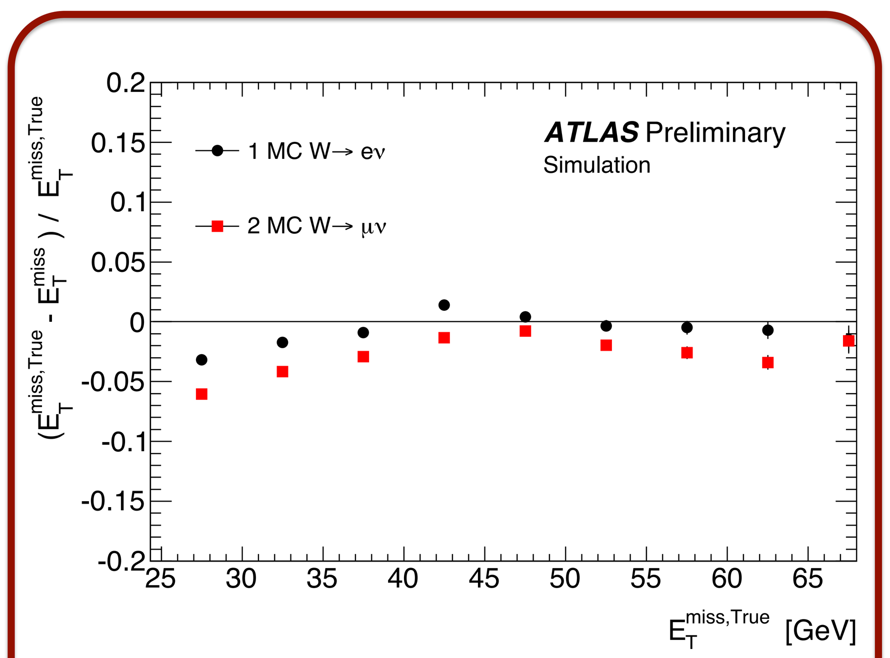
Main results with 2010 data



Comparison data-MC for the ϕ^{miss} distribution for the W→μν channel.



E_T^{miss} resolution for data (left) and MC (right) for different physics channels.



Linearity distribution (MC) for W→eν and W→μν channel.

RefFinal algorithm

The E_T^{miss} is calculated from cells in topoclusters and from muons. TopoCluster cells are calibrated on the basis of the reconstructed physics object they belong to. The algorithm is very flexible and allows one to use the best calibration from each object.

Electrons | Photons | Taus | Jets | SoftJets | Muons | TopoClusters not in objects

Go back to constituent Calorimeter Topoclusters → Cells → apply overlap removal at Cell level → Cell calibration weights dependent on the object → add them to calculate partial terms

MET_RefEle + MET_Refγ + MET_RefTau + MET_RefJet + MET_SoftJets + MET_RefMuon + MET_CellOut + MET_Muon = MET_RefFinal

$$\vec{E}_T^{miss,calo} + \vec{E}_T^{miss,muon} = \vec{E}_T^{miss}$$

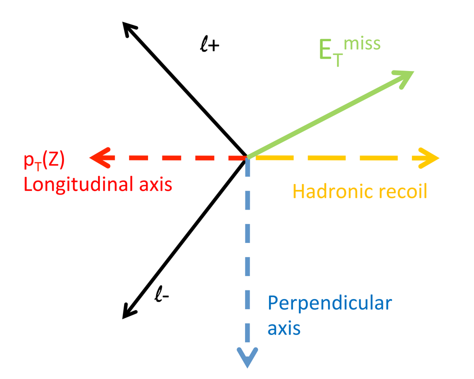
The **Local Hadron Calibration (LCW)** classifies calorimeter clusters as hadronic or electromagnetic, according to cluster topology. Then, it weights each cell in clusters according to cluster properties.

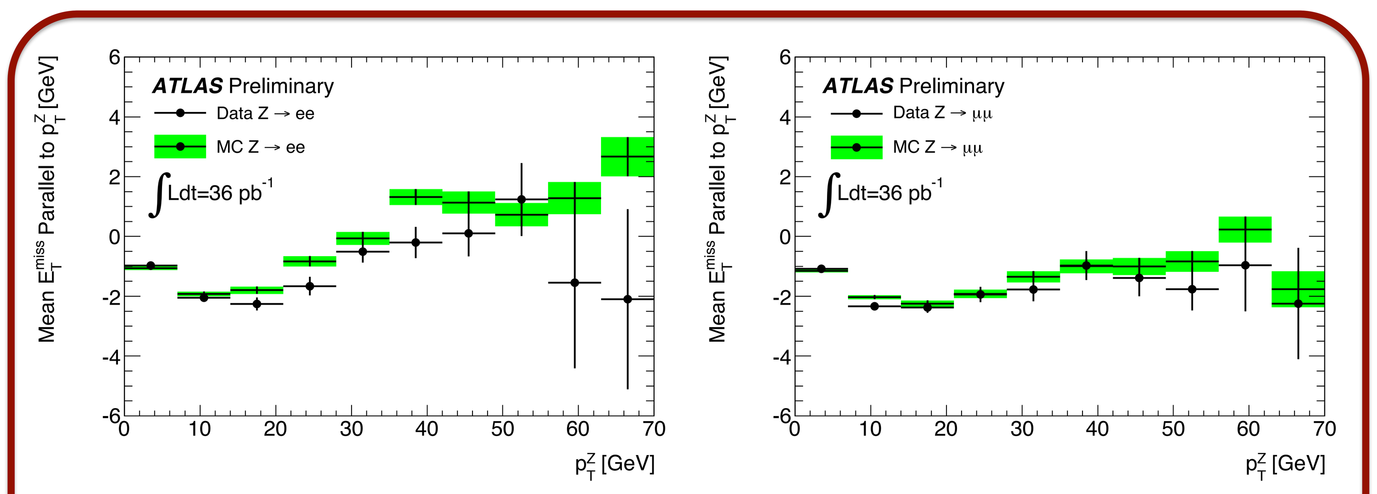
Object	Selection/Algo	p_T threshold	Calibration
Electrons	"robustMediumWithTrack"	> 10 GeV	default electron calibration
Photons	"Tight"	> 10 GeV	EM scale
Taus	"Tight"	> 10 GeV	LCW
Soft jets	anti-k_t R=0.6	7-20 GeV	LCW
Jets	anti-k_t R=0.6	> 20 GeV	LCW+JES
Muons	"Staco combined and Mutag"		
Topoclusters outside objects			LCW+Tracks

Configuration giving the best performance

Main results with 2010 data

In Z events, the longitudinal axis can be defined as the flight direction of the Z boson. Along this axis no E_T^{miss} is expected, because the Z is balanced by the hadronic recoil. A negative bias for low values of p_T^Z is seen, probably due to underestimation of the hadronic recoil.





Mean value of the E_T^{miss} parallel to the Z direction as a function of P_T^Z for Z→ee channel (left) and Z→μμ channel (right)

Systematic Uncertainty

The refined E_T^{miss} makes use of reconstructed objects, so its systematic uncertainty can be calculated from the uncertainty on each high p_T reconstructed objects and from the uncertainty on SoftJets and CellOut terms.

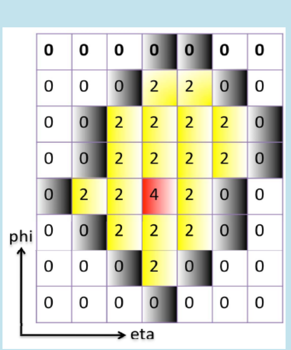
CellOut Systematic uncertainty ~ 13.2%
=> Effect on RefFinal <1%

SoftJets Systematic uncertainty ~ 10.5%
=> Effect on RefFinal <0.5%

Topoclusters

Topoclusters are groups of calorimeter cells topologically connected

- seed cells with $|E_{cell}| > 4\sigma_{noise}$
- expand in 3D: add neighbours with $|E_{cell}|>2\sigma_{noise}$
- merge clusters with common neighbours
- add perimeter cells with $|E_{cell}|>0\sigma_{noise}$



Algorithm for TopoClusters not in objects

The TopoClusters not in objects (CellOut term) are improved using reconstructed tracks:

- add tracks which do not reach the calorimeter or do not seed a topocluster
- when a track is associated to a topocuster the track momentum is used instead of the topocluster energy.

Conclusion

- MC describes data well
- No large tails are observed
- Good resolution
- The calibration for low energy contributions entering in the E_T^{miss} computation has to be further improved

References:

[1] ATLAS Collaboration, *Reconstruction and Calibration of Missing Transverse Energy and Performance in Z and W events in ATLAS Proton-Proton Collisions at √s=7TeV*, ATLAS-CONF-2011-080

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